

obtained by taking the cosine of angle between the direction of average main track and the direction of any fast storm in each square. This would obviously be a very laborious piece of work when the number of fast storms and of the squares is recalled.

TABLE 6.—Average hourly velocity (in miles per hour) of fast storms in each 5-degree square.

Square No.	November.	December.	January.	February.	March.	Square No.	November.	December.	January.	February.	March.
2	47.9	52.3	49.2	49.2	58.7	40	55.0	62.5	59.6	56.5	55.2
3	49.6	50.5	58.2	53.1	59.6	41	54.9	55.6	56.5	55.7	57.5
4	50.5	48.9	53.2	51.1	65.2	42	51.8	57.2	57.5	52.3	57.5
5	52.6	52.9	52.8	53.1	66.9	43	50.6	59.4	59.2	55.2	56.0
6	54.2	56.1	53.3	53.6	53.3	44	50.5	58.9	61.1	57.2	53.5
7	53.6	57.8	55.6	50.9	47.3	45	43.7	53.2	59.2	54.2	56.1
8	53.0	56.3	57.2	45.0	46.2	46	48.6	60.3	58.2	57.0	54.7
9	50.0	59.1	65.6	45.2	54.6	47	49.9	58.6	56.0	56.9	52.4
10	51.7	60.4	74.5	.....	.....	48	53.3	58.1	56.7	52.5	51.8
11	54.2	65.0	.....	55.6	52.1	49	51.2	61.3	54.5	51.9	52.7
12	52.5	61.3	41.7	55.2	52.1	50	57.2	52.3	57.5	55.2	55.2
13	47.5	57.5	58.7	49.6	58.3	51	56.5	56.9	57.0	61.9	57.8
14	44.2	54.2	45.0	62.9	50.2	52	55.4	55.2	57.7	59.5	58.9
15	.....	.....	.....	.....	.....	53	56.7	63.3	62.2	65.5	48.5
16	.....	.....	.....	.....	.....	54	.....	63.7	.....	.....	50.4
17	.....	.....	.....	.....	.....	55	51.4	57.7	53.7	61.7	61.1
18	57.5	61.5	53.2	60.3	54.8	56	51.3	55.5	52.9	61.9	58.0
19	60.0	59.6	57.4	57.7	54.3	57	49.2	57.6	52.3	59.1	57.2
20	57.8	62.5	61.0	58.1	61.6	58	51.3	61.2	59.5	57.7	58.2
21	55.6	58.7	57.8	62.4	60.1	59	53.6	62.3	65.2	60.9	55.0
22	54.6	55.8	54.1	59.6	55.2	60	46.7	50.5	64.8	64.8	55.5
23	55.7	56.5	53.0	53.6	51.6	61	47.9	53.8	61.5	56.6	53.2
24	53.9	58.6	56.3	57.5	51.8	62	.....	57.5	50.2	59.2	50.8
25	52.7	59.5	57.8	52.7	53.9	63	.....	70.6	55.0	58.8	64.2
26	54.2	57.9	54.5	55.5	52.4	64	55.4	51.2	51.6	63.5	68.3
27	53.6	53.4	56.4	54.8	52.5	65	50.2	58.4	57.4	53.9	55.0
28	53.2	54.2	56.2	51.3	52.2	66	.....	60.1	60.8	54.1	52.6
29	51.0	54.6	52.1	53.2	52.7	67	.....	62.4	60.1	56.8	53.9
30	52.5	54.8	55.3	54.0	51.2	68	.....	75.9	59.0	56.6	44.2
31	.....	.....	.....	.....	.....	69	.....	83.1	.....	49.2	69.5
32	.....	.....	.....	.....	.....	70	.....	78.7	.....	.....	84.2
33	63.7	73.3	59.8	59.2	57.4	71	.....	.....	.....	.....	.....
34	56.3	64.9	60.4	60.7	56.7	72	.....	.....	.....	.....	.....
35	56.2	58.2	62.5	59.5	57.6	73	.....	.....	.....	.....	.....
36	55.3	58.0	58.9	59.1	51.2	74	.....	.....	.....	.....	.....
37	54.5	59.1	52.8	61.9	52.7	75	.....	.....	.....	.....	.....
38	53.1	63.6	55.7	57.6	57.4	76	.....	.....	.....	.....	.....
39	.....	.....	.....	.....	.....	77	.....	.....	.....	.....	.....
40	.....	.....	.....	.....	.....	78	.....	.....	.....	.....	.....
41	.....	.....	.....	.....	.....	79	.....	.....	.....	.....	.....
42	.....	.....	.....	.....	.....	80	.....	.....	.....	.....	.....
43	.....	.....	.....	.....	.....	81	.....	.....	.....	.....	.....

The common features of these sketch-maps, on which have been drawn the lines of 50, 55, and 60 miles per hour, are as follows (see Chart XIII):

1. The high velocities (over 60 miles an hour) in the West along the Rocky Mountains.

2. The high velocities (over 60 miles an hour) along the Atlantic coast and also offshore.

In the second case, the high velocities in the east of storms of the southern circuit progressing northeast come in November in the Lake region when the storms cross over to the Canadian side. December is similar to November, except that in the case of the southern circuit a branch track from the Gulf States, with high velocities, joins it, and on the average all velocities are increased 5 miles an hour as compared with November. In January the highest velocities are in the Gulf States and offshore, over the Atlantic, these being due to storms from the western Gulf and South Atlantic States, which enter the branch of the southern circuit trending north-east.

The February map looks somewhat confused, but there seems to be a tendency to return to the distribution of velocities noted in December. The velocities in the Southeastern States are high, but they are lower where the track divides. In March the velocities in the West decrease, the highest velocities are over the Atlantic, where the right-hand branch of the divided southern circuit meets the storms coming from the Gulf and South Atlantic.

It is noticeable that in the months of December to March, in which the eastern portion of the southern circuit divides, the average velocity of fast storms along the right-hand, off, or alongshore track, is greater than that of the left-hand, continental track. An obvious explanation is that the storms offshore move with much less friction over the ocean surface.

In Table 7 are compared the average velocities of the left-hand, or Canadian branch (represented in squares 26, 27,

28) and those of the right-hand or alongshore branch (represented in squares 41, 42, 43) with the differences between these velocities. In all but two cases the differences are positive, which confirms the greater velocity of the alongshore track. The differences would be more striking if smaller squares had been taken. A similar attempt was made in the case of the summer half-year, but was unsuccessful. Data for twenty to thirty years would be necessary in order to give an idea of the distribution of the average velocities in summer.

TABLE 7.—Comparison of average velocities (in miles per hour) of storms along the two branches of the southern circuit.

[Squares 26, 27, 28, represent the left-hand or Canadian branch; squares 41, 42, 43, the right-hand or alongshore branch.]

Squares No.	December.	January.	February.	March.
41.....	55.6	56.5	55.7	57.5
26.....	57.9	54.5	55.5	52.4
Difference (41—26).....	— 2.3	+ 2.0	+ 0.2	+ 5.1
42.....	57.2	57.5	52.3	57.5
27.....	53.4	56.4	54.8	52.5
Difference (42—27).....	+ 3.8	+ 1.1	— 2.5	+ 5.0
43.....	59.4	59.2	55.2	56.0
28.....	54.2	56.2	51.3	52.2
Difference (43—28).....	+ 5.2	+ 3.0	+ 3.9	+ 3.8

THE UNUSUAL RAINFALL OF FEBRUARY AT HONOLULU.

By R. C. LYDECKER, Territorial Meteorologist. Dated March 17, 1904.

The rainfall for February was from four to five times the normal, which is given as 5.6 inches. The average rainfall reported last month was 24.87 inches. According to the monthly summary, Oahu suffered the most in the storms; Maunawili, on this island, reported a fall of 44.65 inches, while in twenty-four hours at the same place 12.50 inches of rain fell. Hawaii suffered the least of any of the islands in the storm, though the big island is usually well to the front in the rain records.

I inclose a barograph sheet (fig. 1) showing the fluctuation of the barometer at Honolulu during the week of heaviest rainfall. The previous records of lower pressure than is shown on this sheet (29.59 on the 11th) are as follows: January 28, 1881, 29.40; February 5, 1901, 29.49; February 13, 1891, 29.57; November 15, 1900, 29.58; February 11, 1904, 29.59.

On this island the rainfall record of 44.25 inches at Luakaha, March, 1902, was broken by a fall of 44.65 at Maunawili. There was no warning of the storm's approach, which set in on the afternoon of the 6th, and between 3 p. m. of that date and 9 a. m. of the 7th 6.22 inches fell at the Weather Bureau. On the 15th there was every indication of this storm passing away, but these indications suddenly ceased, and those of storm No. 2 appeared, which followed closely. It might be said that No. 2 dovetailed into No. 1. During the greater part of these storms calms and light winds prevailed, as noted on the records of observations.

Our heavy rainfalls heretofore have always followed several months of pressure below the normal, and this is the first time that the contrary has been the case since this office was established. It was with this fact in view that, in my summary for November, 1903, I said: "The barometric average for the past five months has been slightly above the normal, a condition likely to be followed by a winter of moderate rainfall," the authority for the statement being the records of this office. Mr. Lyons tells me that in all his experience he has never known a like condition.

The accompanying barogram, from noon of February 8 to noon February 15, shows that during the first three days there

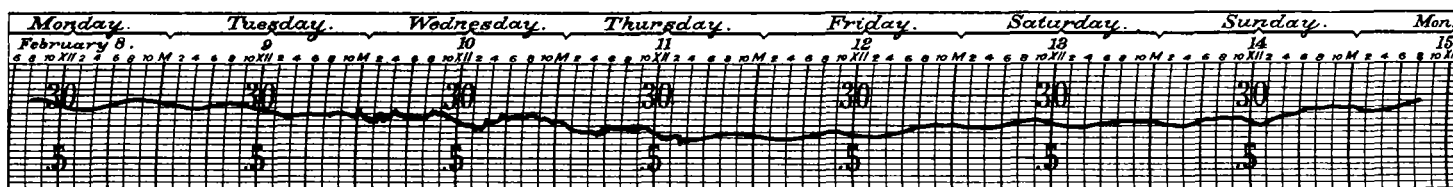


FIG. 1.

was a steady, slow fall of barometric pressure, amounting to 0.25 inch, if we compare only the readings at 9 a. m. During the last three days pressure rose slowly by 0.26 inch from 9 a. m. of the 12th to the 15th. It does not necessarily follow that Honolulu was on the outskirts of a moving hurricane or typhoon. To decide that question, one must have the wind records. It is equally possible that we here have to do with a slow oscillation of the location of the general area of tropical high pressure northeast of Honolulu or of equatorial low pressure south of Honolulu. Evidently the word "storms," as used by Mr. Lydecker, refers only to rainfall, as there was neither high wind nor rapid changes in barometric pressure. There can hardly be any doubt but that under these circumstances the rainfall represents the result of changes going on in wind, moisture, and temperature in the cloudy layer and the higher regions of the atmosphere; changes that are due to slight and widespread changes in atmospheric pressure. Similar changes occur within the regions of our own daily weather maps. A fall of a tenth of an inch in pressure, or less, in the equatorial regions, as shown by reports from Colon, the West Indies, or Mexico, is likely to be at once followed by a cold wave spreading from Canada southward over the Valley of the Mississippi. Before the front of the cold wave reaches the Gulf of Mexico rain and snow are likely to occur, and as soon as it reaches the warm waters of the Gulf they are certain to occur. The atmosphere is so mobile, or, in other words, viscosity is so small a factor, that slight gradients of pressure, not always recognizable on our present meteorological maps, quickly set it in motion. The resistances introduced by the irregularities of the ground may require a slight additional gradient to overcome them, but in a general way the progress of a cold wave toward the Gulf of Mexico, like the progress of the great monsoon wind from the southern Indian Ocean across the equator to the shores of Hindostan, is maintained by a slight gradient entirely different from the steep gradients that prevail within a whirlwind. Therefore it is that a fall of a tenth of an inch in twenty-four hours is an important matter and almost certainly a forerunner of rain in India, the West Indies, Honolulu, and the Philippines. These all represent moist climates at about 20° north latitude, where the ascent of the air to the extent of a few thousand feet cools it sufficiently to produce cloud and rain.

Those who wish to make a minute study of the fluctuations shown on the accompanying facsimile of the Honolulu barogram (fig. 1) may correct it for slight deviations from the readings of the standard mercurial barometer by means of the following table of corrections furnished by Mr. Lydecker:

Time.*	Standard pressure.†	Correction to barogram.‡
February 8, 9 a. m.	29.95	0.00
February 9, 9 a. m.	29.93	0.00
February 10, 9 a. m.	29.83	-0.03
February 11, 9 a. m.	29.70	-0.04
February 12, 9 a. m.	29.68	-0.02
February 13, 9 a. m.	29.77	-0.01
February 14, 9 a. m.	29.79	-0.01
February 15, 9 a. m.	29.94	0.00

* Honolulu date and standard time, 157° 30'. † Reading of standard mercurial barometer at 9 a. m., reduced to standard temperature, sea level, and gravity. ‡ Correction to be applied to the readings of the barometer in order to obtain standard pressures.

C. A.

DUST IN THE ATMOSPHERE DURING 1902-3.

By ANDREW NOBLE, Esq., Rozelle, Sydney, N. S. W. Dated July 16, 1904.

I have been much interested in the recent notices that have appeared relative to a diminution in the transparency of the earth's atmosphere during 1902-3, and more particularly in the article that appeared at page 111 of the MONTHLY WEATHER REVIEW for March, 1904, and, in response to the request of the Editor, published in Nature, vol. 70, May 19, 1904, at page 60, I have gone through my notes and scrapbook in order to collect any matter that may be of service to him. Duststorms were characteristic of the late 9-years' drought in Australia, especially during the latter stages. It is difficult to give an adequate idea of the effect produced by these dust or sand storms. The soil, made loose and friable by the prolonged absence of rain, no longer able to withstand the wind, was swirled up and carried across country with resistless force. In many cases it was torn up to a depth of one foot, or down to solid clay. On a station in the Wileunia district 100,000 acres were left as bare as a floor, upon which a heavy rain that followed had no effect. In one case 12 feet of sand were deposited in a bank in three months. Wherever a little resistance offered, the sand accumulated, and eventually formed a dune. Wire-netted rabbit-proof fences were buried in this way, and even a second story to the fence shared a similar fate. On the Albemarle station (latitude 32° 13', longitude 142° 40') a 7-foot stock yard fence was so completely submerged within eighteen months of erection that the owner drove over it in his buggy. Numerous instances are given of daylight becoming completely obscured during the progress of these storms, and, in consequence, lamps had to be lit. All traffic stopped; people lost their way, not being able to see their hands when held up before their faces; and fowls went to roost in the daytime. Although intermittent during the winter months of 1902, these storms renewed their activity much earlier than usual during the following spring. Early in September, 1902, the ship *Wakatipu* encountered in Bass Straits a rain squall accompanied by a "fall of fine chocolate mud." The wind was west-southwest at the time. The early return of these storms during 1902 was undoubtedly due to the intensified character of the drought in central Australia during the antecedent six months. Referring to this period, Sir Charles Todd writes:

During the past winter the six months rainfall (April to September) at 37 selected stations in South Australia is, without exception, far below the average amount. It is, in fact, one of the driest years ever experienced. So far as all the northern areas are concerned, it is the driest, and the same applies to many parts of the south. At 24 out of 37 stations the winter of 1902 is the driest on record, while at 8 others only one other year was drier.

It is in this part of Australia that our duststorms have their origin. Sturt, the explorer, in his diary writes:

North and northwest of Flinders Range are large plains, extending as far as latitude 25°. To the north of that latitude, though the sun was intensely hot, there were no hot winds; in fact from that parallel of latitude to the Indian Ocean, either going or coming, they were not met with. On reaching latitude 27° on my return, I found the hot winds prevailing again, as on my outward journey. I saw no sandy desert, to which these hot winds had been attributed, but on lifting some of the stones that were lying on the surface I found them so hot that I was obliged to drop them immediately. It is my opinion that when a hot wind blows across these stone-covered plains it collects the heat from them, and the air becoming rarified is driven on southward with increased vehemence.